AQA 2 Answers – Forces and Motion (set 2)

June 12 Q1

1	a	i	two from: velocity, acceleration, force etc ✓	1
1	a	ii	two from: speed, distance, mass etc ✓	1
1	b	i	B: drag / air resistance ✓ C: weight ✓	2
1	b	ii	closed triangle (of vectors) ✓ so forces are in **equilibrium / resultant force is zero / forces balance** (so moving at constant velocity) ✓	2
1	c		$W = 9500 \sin 74$ ✓ = 9100 ✓ (9132) **2 sf** ✓	3
2	a		*GPE* to *KE* to *GPE* ✓ no energy lost (from system) / no work done against resistive forces ✓ initial *GPE* = final (*GPE*) / initial (*GPE*) = final *GPE* **OR** $h = GPE/mg$ and these are all constant so h is the same ✓	3

June 13 Q2

2	a	i	$(s = \frac{1}{2}gt^2)$ $1.5 = \frac{1}{2}9.81t^2$ OR $t = \sqrt{\frac{2s}{g}}$ OR $t = \sqrt{\frac{2\times1.5}{9.81}}$ ✓ (= 0.553) = 0.55 (s) ✓	2	Allow g=10 (0.5477) 0.6 gets 2 marks only if working shown. 0.6 on its own gets 1 mark.
2	a	ii	$(s = vt = 430 \times 0.553 = 237.8 =)$ 240 (m) ✓ ecf a(i)	1	
2	b		their vertical motion is independent of their horizontal motion **OR** downward /vertical acceleration is the same for both **OR** acceleration due to gravity is the same for both **OR** vertical speed/velocity is the same for both ✓ (bullets A and B will be in the air) for the same time ✓ (Horizontal acceleration is zero and thus horizontal) distance is proportional to horizontal speed **OR** $s = ut$ where u is the horizontal velocity ✓	3	Allow 'time is constant' Don't allow 'similar' 'velocity smaller so distance smaller' is not sufficient

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June 13 Q3

3	a		vol = $\frac{4}{3}\pi 0.011^3$ = (5.5753) 5.6×10^{-6} (m^3)✓ ($m = \rho V$) (= 8100 × 5.575×10^{-6} =) 0.045 (kg) ✓ ecf from first part **candidate's mass x g** (W = 0.045160 × 9.81 = 0.44302 = 0.44 N) ✓ **any 2sf** ✓	4	Allow use of g = 10 0.36kg , 3.5N from use of diameter rather than radius (max 3 from 4)
3	b	i	**The candidate's writing should be legible and the spelling, punctuation and grammar should be sufficiently accurate for the meaning to be clear.** The candidate's answer will be assessed holistically. The answer will be assigned to one of three levels according to the following criteria. **High Level (Good to excellent): 5 or 6 marks** The information conveyed by the answer is clearly organised, logical and coherent, using appropriate specialist vocabulary correctly. The form and style of writing is appropriate to answer the question. Mentions **all** of the following: • velocity (or speed) increases and then becomes constant (terminal velocity) • acceleration reduces to zero • forces become equal / balanced • weight (allow 'gravity') and drag/friction correctly identified	5-6	
3	b	i	**For 6 marks: In addition to the above, two of the following:** • drag force increases with speed • (weight /downward force initially) greater than drag/friction etc • resultant force causes acceleration • Resultant force = W – drag • acceleration = gradient • acceleration is maximum (9.81) at the beginning **Intermediate Level (Modest to adequate): 3 or 4 marks** The information conveyed by the answer may be less well organised and not fully coherent. There is less use of specialist vocabulary, or specialist vocabulary may be used incorrectly. The form and style of writing is less appropriate. Mentions the **two** following points: • velocity (or speed) increases **OR** velocity (or speed) becomes constant / terminal velocity reached • acceleration decreases **OR** acceleration becomes zero **AND** for 3 marks: mentions **one** more valid point from the 4 above or from the 7 below: for 4 marks: at least two additional points with at least one from the 'Forces' list	3-4	

			• acceleration = gradient • acceleration is maximum (9.81) at the beginning **Forces** • weight greater than drag (before terminal velocity) • there is a resultant force downwards (before terminal velocity) • forces become equal/ balanced / drag = weight • drag force increases with speed. • Resultant force = W – drag **Low Level (Poor to limited): 1 or 2 marks** The information conveyed by the answer is poorly organised and may not be relevant or coherent. There is little correct use of specialist vocabulary. The form and style of writing may be only partly appropriate. **One** valid point from list below For two marks: **Two** valid points **The explanation expected in a competent answer should include a coherent selection of the following points concerning the physical principles involved and their consequences in this case.** Mention of the points below may influence the mark given within each category: • velocity increases • velocity becomes constant (terminal velocity) • acceleration is maximum (9.81) at the beginning • acceleration decreases (to zero) • weight greater than drag (before terminal velocity)	1-2	Poor QWC may result in award of the lower mark within a band. **Max 3 for mention of deceleration or increasing acceleration** Several serious misconceptions may reduce a 2 mark answer to 1

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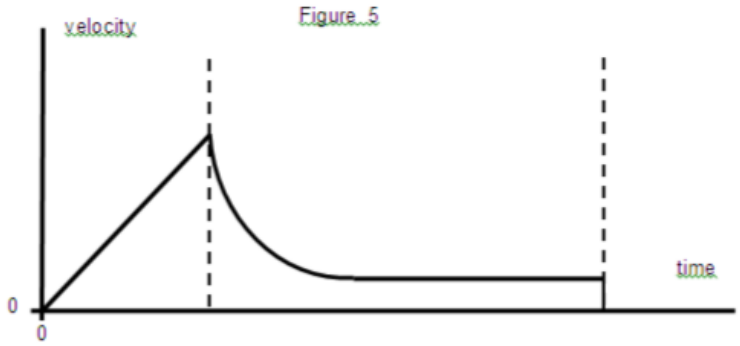
			• there is a resultant force downwards (before terminal velocity) • forces become equal/ balanced / drag = weight • drag force increases with speed. • resultant force = W – drag • acceleration = gradient valid point explaining why rapid decrease in velocity occurs when ball hits bottom of container. E.g. resultant upward force (decelerates the ball)		
3	b	ii	Figure 5  straight line with positive gradient from origin to first dotted line ✓ descending line (curved or straight but non-vertical) starting from a point on first dotted line (must not have negative velocity at any point) and the line may then become horizontal ✓ curved line descending from first dotted line which is a continuation of the initial line (the gradient must be decreasing initially (a curve) and the line may then become horizontal **AND** extending up to second dotted line (with positive non-zero velocity) **AND** no **incorrect** continuation of line beyond second time line ✓ **OR** straight line with positive gradient from origin to first dotted line ✓ straight line with positive gradient from origin to first dotted line **AND** ascending curved line with positive gradient decreasing, starting from a point on first dotted line (continuation of first line) ✓ extending up to second dotted line **AND** no **incorrect** continuation of line beyond second time line ✓	3	3rd mark: Allow lines that become straight with a constant negative gradient after a curve. Vertical line at the end is not necessary. End of line must be between start of 'e' in 'time' and end of 'w' in 'when'. Allow correct lines beyond the second time line: continuous zero velocity or falling below x axis and rising back to x axis (bouncing) but not reaching a higher speed than descent

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June 14 Q2

2	a	i	Use of $\left(s = \frac{1}{2}gt^2\right)$ OR $t^2 = 2s/g$ ✓ $t = \sqrt{\frac{2 \times 1.2}{9.81}}$ ✓ = 0.49 (0.4946 s) ✓ allow 0.5 do not allow 0.50	3		Some working required for full marks. Correct answer only gets 2
2	a	ii	*(s= vt)* = 8.5 x 0.4946 ✓ ecf ai = 4.2 m ✓ (4.20) ecf from ai	2		
2	b	i	$\left(s = \frac{1}{2}(u+v)\,t\right)$ $t = \frac{2s}{u(+v)}$ or correct sub into equation above ✓ $= \frac{2 \times 0.35}{8.5}$ = 8.2 x 10^{-2} (s) ✓ (0.0824) allow 0.08 but not 0.080 or 0.1	2		Allow alternative correct approaches
2	b ii		*a* = (*v*-*u*) / *t* OR correct substitution OR a= 103 ✓ (= -8.5) / 8.24 x 10^{-2} = 103.2) (*F* = *ma* =) 75 x (103.2) ✓ ecf from bi for incorrect acceleration due to arithmetic error only, not a physics error (e.g. do not allow a = 8.5. Use of g gets zero for the question. = 7700 N ✓ (7741) ecf (see above)	3		Or from loss of KE Some working required for full marks. Correct answer only gets 2

AQA 2 Answers – Forces and Motion (set 2)

June 15 Q1

1a

Velocity and speed correct ✓
Distance and displacement correct ✓

	velocity	speed	distance	displacement
vector	✓			✓
scalar		✓	✓	

2

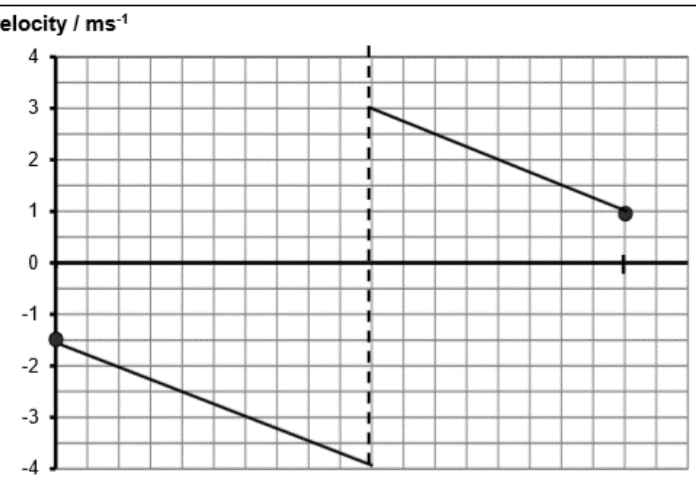
1bi

$v^2 = u^2 + 2as$
$v = \sqrt{u^2 + 2as}$ ✓ $v = \sqrt{1.5^2 + 2 \times 9.81 \times 0.65}$ ✓
= (-)3.9 (m s^{-1}) ✓two or more sig fig needed (- 3.87337 m s^{-1})

1st mark for equation rearranged to make v the subject (note sq^r root may be implied by a later calculation)
penalise the use of g = 10 m s^2 only on this question
2nd mark for substituting numbers into any valid equation
3rd mark for answer
Alt' approach is gainKE=lossPE
Missing out *u* gives zero marks
Answer only gains one mark
[Note it is possible to achieve the correct answer by a wrong calculation]

3

1bii



first line descends from X to the dotted line at t_A or up to one division sooner ✓
(allow line to curve)

first line is straight and descends from X to *v* = -4 (m s^{-1}) ✓(allow tolerance one division)
second line has same gradient as the first , straight and descends to v = 1(m s^{-1}) ✓
(tolerance ½ division)
A steep line may join the two straight lines but its width must be less than 2 divisions

3

1c

$s = ut + 1/2at^2$
$t = \sqrt{\frac{2s}{a}}$ OR correct substitution seen into either equation $t = \sqrt{\frac{2\times1.2}{9.81}}$ ✓
= 0.49 (s) ✓ (0.4946 s)

$v = s/t$
= 5.0 / 0.49 = 10 (m s^{-1}) ✓ (10.2 m s^{-1}) (allow CE from their time)

working must be shown for the first mark but not the subsequent marks.

[Note it is possible to achieve the correct answer by a wrong calculation]

3

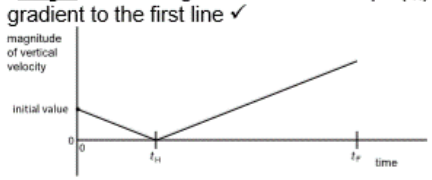
AQA 2 Answers – Forces and Motion (set 2)

June 15 Q3

3ai	($a = (v-u)/t$) = 27.8 (-0) / 4.6 = 6.04 ✓ = 6.0 (ms^{-1}) ✓	no need to see working for the mark 2 sig fig mark stands alone	2	
3aii	($F = ma$) = (360 + 82) x 6.0(4) ✓ (allow CE from 3ai) = 2700 (N) ✓ (2670 N or 2652 N)	$F = 442 \times$ a(i) 1 mark may be gained if mass of rider is ignored giving answer 2200N from 2175N	2	
3b	(forward force would have to) increase ✓ air resistance/drag increases (with speed) ✓ driving/forward force must be greater than resistive/drag force✓ (So that) resultant/net force stayed the same / otherwise the resultant/net force would decrease ✓	no mark for wind resistance	4max3	
3c	horizontal force arrows on both wheels towards the right starting where tyre meets road or on the axle labelled driving force or equivalent ✓ A horizontal arrow to the left starting anywhere on the vehicle labelled drag/air resistance ✓	ignore the actual lengths of any arrows ignore any arrows simply labelled 'friction' no mark for wind resistance, resistance or friction force the base of an arrow is where the force is applied	2	
3d	($F = P/v$) = 22 000/ 55✓ Condone 22/55 for this mark = 400 ✓ (N)		2	

AQA 2 Answers – Forces and Motion (set 2)

June 16 Q2

2(a)(i)	(using sin 25° = V_V/V $V = V_V$ / sin 25°) = 5.0 / sin 25° ✓ 11.8 (m s^{-1}) ✓ (working and answer is required)	Look out for cos 65° = sin 25° in first mark. Also calculating the horizontal component using cos 25° followed by Pythagoras is a valid approach. Working backwards is not acceptable.	2	
2(a)(ii)	(using tan 25° = V_V / V_H) $V_H = V_V$ / tan 25° ✓ = 5 / tan 25° = 11 (m s^{-1}) ✓ (10.7 m s^{-1}) Or (using cos 25° = V_H / V) $V_H = V$ cos 25° ✓ = 11.8 cos 25° = 11 (m s^{-1}) ✓ (10.7 m s^{-1}) Or (using $V_H^2 + V_V^2 = V^2$) $V_H^2 + 5^2 = 11.8^2$ ✓ (0r 12^2) V_H = 11 (m s^{-1}) ✓ (10.7 m s^{-1})	Note 1/cos 65° = sin 25° and tan 25° = 1/ tan 65° Rounding means answers between 10.7 and 11 m s^{-1} are acceptable.	2	
2(b)(i)	(using $v^2 = u^2 + 2as$ with up being positive $0 = 5.0^2 + 2 \times -9.81 \times s$) s = 1.3 (m) ✓ (1.27→1.28 m) or (loss of KE = gain of PE ½ ~~m~~ v^2 = ~~m~~ g h ½ 5.0^2 = 9.81 x h) h = 1.3 (m) ✓ (1.27→1.28 m) quoted to 2 sig figs ✓	for the sig fig mark the answer line takes priority. If a choice of sig figs given and not in answer line – no sig fig mark Sig fig mark stands alone provided some working is shown	2	
2(b)(ii)	(using $s = (u + v)t/2$) or horizontal distance = speed × time) s = 11 × 1.3 = 14 (m) ✓ (using 10.7 gives the same answer)	allow CE s = (aii) × 1.3 but working must be seen	1	
2(c)(i)	**A** marked at the point of landing or immediately before ✓	The **A** or its marked position must not be further to the left than the 'c' in the word 'scale'.	1	
2(c)(ii)	**B** marked at the maximum height of the path ✓	The B must lie vertically between the 'r' and 'a' in the word 'resistance above figure 2.	1	
2(d)	straight line from point given down to point t_H on the axis ✓ straight line starting where first line stops (t_H) but with opposite gradient to the first line ✓  	(A measure of accuracy for the second mark) The second line must end (t_F) between the height of the vertical axis and half this height. Obviously straight lines drawn by hand are acceptable.	2	

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June 16 Q3

3(a)	(using $F = ma$) a (= F/m) = 1400 / (any mass/masses taken from the table) ✓(any arrangement gains mark) = (1400/(2600 + 2900 + 1300) = 0.206 m s^{-2}) = 0.21 (m s^{-2}) ✓	Allow any single or combination of masses from the table for first mark. 0.21 m s^{-2} on its own gains 2 marks but 0.2 m s^{-2} on its own gains 1 mark 1 sig fig is not acceptable	2	
3(b)(i)	they have the same line of action they have the same magnitude (not size) the forces are of the same kind ✓ any one statement	The statement must be of a general nature. The statement 'equal magnitude + opposite direction does not make the similarity clear and so gains zero marks. If forces act against each other or cancel or act on the same body this mark is lost.	1	
3(b)(ii)	they are in opposite directions they act on different bodies ✓ any one statement	The statement must be of a general nature. If forces act against each other or cancel or act on the same body this mark is lost.	1	
3(c)	they do not have the same magnitude/size the forces are of different types they do not act on different bodies drag is greater than the weight there is a resultant force (as deceleration occurs) ✓ any one statement	Statements can be written negatively	1	
3(d)	actual deceleration (= F/m) = 670 / 890 = 0.75 (m s^{-2}) ✓ (0.753 m s^{-2}) minimum required deceleration = $\Delta v / \Delta t$ = (5.5 – 3.0) / 3.5 = 0.71 (m s^{-2}) ✓ (0.714 m s^{-2}) therefore (compared to 0.75 m s^{-2}) there is sufficient deceleration, yes ✓ Or actual deceleration	ignore any interchange between acceleration and deceleration	3	
	(= F/m) = 670 / 890 = 0.75 (m s^{-2}) ✓ (0.753 m s^{-2}) maximum required time = $\Delta t = \Delta v/a$ = (5.5 – 3.0) / 0.753 = 3.3 s (3.32 s) ✓ therefore (compared to 3.5 s) there is sufficient time, yes ✓ Or actual deceleration (= F/m) = 670 / 890 = 0.75 (m s^{-2}) ✓ (0.753 m s^{-2}) (using v = u + at) v = 5.5 – 0.753 x 3.5 = 2.8 (m s^{-1}) ✓ which is a safe landing speed ✓ Or (using $Ft = \Delta mv$) 670 × 3.5 = 890 × Δv ✓ Δv =2.7 landing speed = 5.5 – 2.7 = 2.8 (m s^{-1}) ✓ which is a safe landing speed ✓	3rd mark is dependent on having a valid attempt at the calculation. 3rd mark can be given for wrong answer if it follows from an arithmetic error.		
	(F = ma) = 0.4 x 4.59 ✓ = (1.84 N)			